THE PREDICTION OF SUBMARINE OFFICER ADVANCED COURSE ASCENDANCY FROM SUBSCREEN TEST SCORES

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SUMMARY PAGE

Objective: The Department of the Navy (DON) began a Human Capital Strategy (HCS) agenda in 2004 and incorporated this agenda into its objectives for 2005. The HCS agenda advances several pursuits, including attempts to (1) decrease overall manpower costs within the DON while improving operational effectiveness, (2) implement an integrated organizational approach to career progression/advancement, and (3) establish actionable metrics to accomplish these goals. One way the Submarine Force (SUBFOR) could meet the HCS agenda would be to select fewer officers for submarine training, which would reduce manpower costs. However, in order to avoid a subsequent manpower shortage from this force reduction and thus maintain operational effectiveness, SUBFOR would need to have an actionable metric, or predictor, that would allow for the selection of those officers for submarine training who are the most likely to remain and advance within SUBFOR. This study investigated whether or not the SUBSCREEN test could be used to provide a predictor of advancement among officers within SUBFOR. A prediction equation within the SUBSCREEN test which identifies the officers that are the most likely to remain within SUBFOR could eventually provide the Navy with an actionable metric that could be used to (1) select fewer officers for submarine training, (2) reduce training costs, and yet (3) increase the retention of the submarine officers who are the most likely to advance in their careers and thus (4) maintain operational effectiveness.

Method: During attendance of Submarine Officer Basic Course (SOBC), students are required to take the SUBSCREEN test per Naval Submarine School (NAVSUBSCOL) Instruction 6420.1 (see Appendix A). SUBSCREEN is a 240-item test of mental health functioning, motivation, and environmental adaptability. The SUBSCREEN test is used to evaluate the "psychological fitness" of Naval personnel for submarine training and duty as mandated by the Manual of the Medical Department of the U.S. Navy (MANMED) in Article 15-69, paragraph 2(i) (see Appendix B). Consequently, this study was undertaken to determine if the SUBSCREEN test could provide an actionable metric which predicts which of the SOBC students are the most likely to progress in their careers to the Submarine Officer Advanced Course (SOAC), and thus advance to Department Head billets within the Submarine Fleet. To wit, a database of submarine officers who had ascended to SOAC was combined with a database of submarine officers who were not selected for SOAC, and these two known-groups were compared via SUBSCREEN test scores to identify, retrospectively, scales which ultimately predicted advancement to SOAC.

Findings: Using correlation and regression techniques, we found that six motivational scales and one response-set scale within the SUBSCREEN test formed an optimal linear composite that predicted which SOBC students were likely to advance to SOAC, with $R = .25$ ($p < .001$). Several advantageous initial cutpoints were identified for this prediction equation, which was termed the Submarine Officer Retention Test, or SORT.

Application: SORT, and the motivational traits that comprise the SORT, could be used as actionable metrics that enhance officer selection decisions for submarine training. However, further tests of this application of SUBSCREEN's SORT may be required. If administration of the SUBSCREEN test were to be placed earlier in the accession pipeline, e.g., prior to Nuclear Power School rather than during SOBC, this administrative change could moderate the accuracy of SORT's predictions, and this possibility would require empirical investigation.

ADMINISTRATIVE INFORMATION

ABSTRACT

The Department of the Navy (DON) began a Human Capital Strategy (HCS) agenda in 2004 and incorporated this agenda into its objectives for 2005. The HCS agenda advances several pursuits, including attempts to (1) decrease overall manpower costs within the DON while improving effectiveness, (2) implement an integrated organizational approach to career progression/advancement, and (3) establish actionable metrics to accomplish these goals. One way the Submarine Force (SUBFOR) could meet the HCS agenda would be to select fewer officers for submarine training, which would reduce manpower costs. However, in order to avoid a subsequent manpower shortage from this force reduction and thus maintain operational effectiveness, SUBFOR would need to have an actionable metric, or predictor, that would allow for the selection of those officers for submarine training who are the most likely to remain and advance within SUBFOR. This study investigated whether or not the SUBSCREEN test could be used to provide a predictor of advancement among officers within SUBFOR. SUBSCREEN is a 240-item test of mental health functioning, motivation, and environmental adaptability used to evaluate the "psychological fitness" of Naval personnel for submarine training and duty. Using correlation and regression techniques, we found that six motivational scales and one response-set scale within the SUBSCREEN test formed an optimal linear composite that predicted which Submarine Officer Basic Course (SOBC) students were likely to advance, approximately seven years later, to the Submarine Officer Advanced Course (SOAC), with $R = .25$ ($p < .001$). Several advantageous initial cutpoints were identified for this prediction equation, which was termed the Submarine Officer Retention Test, or SORT. In the future, the SORT, and the motivational traits that comprise the SORT, could be used as actionable metrics that enhance officer selection decisions for submarine training. However, further tests of this application of SUBSCREEN's SORT may be required as administration of the SUBSCREEN test could profitably be placed earlier in the training pipeline, prior to Nuclear Power School rather than during SOBC, and this administrative change could moderate the accuracy of SORT's predictions.

INTRODUCTION

Trying to do more with less is an ongoing struggle in the Department of Defense, as budgets remain relatively stable while demands increase. In 2004 the Department of the Navy (DON) began a Human Capital Strategy (HCS) agenda, and incorporated this agenda into its objectives for 2005. The HCS agenda advances several pursuits, including attempts to (1) decrease overall manpower costs within the DON while improving effectiveness, (2) implement an integrated organizational approach to career progression/advancement, and (3) establish actionable metrics to accomplish these goals. The HCS agenda is Navy-wide, and all forces, including the Submarine Force (SUBFOR), are attempting to pursue HCS goals. One way SUBFOR could meet part of the HCS agenda would be to select fewer officers for submarine training, which would reduce manpower costs. However, in order to avoid a subsequent manpower shortage from this force reduction and thus maintain operational effectiveness, SUBFOR would need to have an actionable metric, or predictor, that would allow for the selection of those officers for submarine training who are the most likely to remain and advance within SUBFOR.

Submarine Officer Basic Course (SOBC) is the first sub-specific step in training sub officers, and is only offered at SUBASE NLON. During attendance of SOBC, students are required to take the SUBSCREEN test per Naval Submarine School (NAVSUBSCOL) Instruction 6420.1 (see Appendix A). SUBSCREEN is a 240-item test of mental health functioning, motivation, and environmental adaptability (Bing & Eisenberg, 2004). The SUBSCREEN test is used to evaluate the "psychological fitness" of Naval personnel for submarine training and duty as mandated by the Manual of the Medical Department of the U.S. Navy (MANMED) in Article 15-69, paragraph 2(i) (see Appendix B). SUBSCREEN is administered and maintained by Naval Submarine Medical Research Laboratory (NSMRL), and used by NAVSUBSCOL to screen both SOBC and Basic Enlisted Submarine School (BESS) students for potential incompatibilities (e.g., claustrophobia) with the submarine environment. SUBSCREEN consists of many scales that measure Affective (e.g., situational control, depression, nervousness), Socialization (e.g., aggression, social isolation, impulsiveness, coercive tendencies), and Motivational (e.g., mistake joining submarines, uncertain about submarines) factors. SUBSCREEN also contains scales that detect response distortion (e.g., faking good), and the scoring program uses additional algorithms to identify response patterns indicative of faking attempts. Additional scales are composed of items used to assess suicidal ideation, claustrophobia, self-criticism, unusual thoughts, and unusual physical complaints. Students respond to each item on the SUBSCREEN test by using a five-point Likert scale with the following response options: agree strongly, agree, does not apply, disagree, and disagree strongly.

Currently, each SOBC student's scale scores are compared to the scale score norms (i.e., means and standard deviations) obtained from over 4,000 SOBC students who have taken the test over the last 10 years. Approximately 12% of SOBC students are referred to the Mental Health Clinic of the Naval Ambulatory Care Center (NACC) in Groton for a mental health evaluation because of their SUBSCREEN test scores. *In general*, for any scale score to warrant a referral, it must be more extreme (i.e., higher or lower depending upon the referral criterion) than approximately 98% of the other scores in the SOBC student norms database. In other words, the score must land in or above the 98th percentile (i.e., +2.054 standard deviations above the mean) to warrant referral, or possibly on or below the 2nd percentile (i.e., -2.054 standard deviations below the

mean) to warrant referral, depending upon the referral criterion. There are over 20 standardized referral criteria in the scoring program for the test, and thus over 20 possible reasons for referral and further evaluation within any single SUBSCREEN test profile. As many SUBSCREEN scales are intercorrelated, the SUBSCREEN profiles for students requiring further evaluation often contain more than one referral reason.

As stated above, the SUBSCREEN test is administered by NSMRL, and the SUBSCREEN answer sheets are subsequently scored at NSMRL. SOBC students who have indications or an indication of incompatibility with submarine training and/or duty (e.g., are +1.96 standard deviations above the mean on the suicidal ideation scale) according to their SUBSCREEN profile are referred to the Mental Health Clinic for a mental health status interview and further evaluation. The Mental Health Clinic receives a list of names of those to be interviewed as well as the SUBSCREEN profile report, which contains the SUBSCREEN test scores and the specific referral reasons. The SUBSCREEN profile reports and the referral reasons aid the interviews and help to guide the subsequent final dispositions reached by the Mental Health Clinic. NAVSUBSCOL receives only the list of names of those to be referred to the Mental Health Clinic in order to coordinate the interviews of their students with other SOBC activities (e.g., classes, meetings, damage control training sessions, etc.). After the conclusion of the mental health status interview and perhaps further testing and/or treatment, the Mental Health Clinic reaches one of three recommended final dispositions for the student: (1) qualified for submarine training and duty and recommend a return to SOBC for training, (2) unqualified for submarine training and duty and recommend a transfer to the Surface Fleet, and (3) unqualified for submarine training and duty and recommend administrative separation (ADSEP). The final disposition is sent to NAVSUBSCOL as a recommendation. The leadership at NAVSUBSCOL then decides the final outcome for the SOBC student. In sum, the SUBSCREEN test occupies the first step of a mandatory, multi-step "select out" process used to evaluate the "psychological fitness" of Naval personnel for submarine training and duty (MANMED, Article 15-69, paragraph 2(i)).

A recent innovation in the SUBSCREEN program came in the form of a new actionable metric within the SUBSCREEN test, which was created in the fall of 2001. This actionable metric, or empirical predictor, was based on SUBSCREEN scale scores, and was created for the purpose of predicting fleet attrition among BESS students (Bing & Eisenberg, 2003a). This predictor was eventually named the Submarine Attrition Risk Scale, or SARS, and then renamed to the SubMarine Attrition Risk Test, or SMART (Bing & Eisenberg, 2003b, 2004).

The SMART is an optimal linear composite of scales within the SUBSCREEN test that predict adverse (e.g., misconduct, substance abuse) and early (i.e., prior to end of first enlistment) fleet attrition among BESS students (Bing & Eisenberg, 2004). The SMART does not provide a psychological diagnosis, but simply provides the probability with which one can expect a BESS student to separate for negative reasons once he reaches the fleet. The SMART has been prospectively validated against early attrition indicators, such as nonjudicial punishment (NJP) events and legal hold status for alleged criminal activities (Bing & Eisenberg, 2003b).[1] The

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[1] "…NJP…refers to certain limited punishments which can be awarded for minor disciplinary offenses by a commanding officer or officer in charge to members of his/her command. In the Navy and Coast Guard, nonjudicial punishment proceedings are referred to as 'captain's mast' or simply 'mast'" (Powers, 2005, p. 1).

SMART is a statistically significant predictor of these early attrition indicators, and the higher an enlisted student scores on the SMART, the more likely he is to commit an act that will eventually result in disciplinary action (e.g., NJP) and separation from the Navy.

In sum, the SMART is a subset of the SUBSCREEN test, and potentially useful for evaluation, treatment, and separation decisions made for BESS students. As a result, the use of SUBSCREEN's SMART may eventually help the Navy to meet HCS objectives within the *enlisted* submarine community. In fact, currently a 6.4, BUMED-funded Test and Evaluation (T&E) of the SMART is underway to determine whether or not SUBSCREEN's SMART can be used to increase performance and retention among BESS students (Bing, 2005; see Appendix C).[2] However, currently the SUBSCREEN program does *not* have an actionable metric that is analogous to the SMART for the *officer* submarine community. Consequently, this study was undertaken to determine if the SUBSCREEN test could provide an actionable metric which predicts which of the SOBC students are the most likely to advance in their careers to the Submarine Officer Advanced Course (SOAC), and thus progress to Department Head billets within the Submarine Fleet. A prediction equation within the SUBSCREEN test which identifies the officers that are the most likely to remain within SUBFOR could eventually provide the Navy with an actionable metric that could be used to (1) select fewer officers for submarine training, (2) reduce training costs, and yet (3) increase the retention of the submarine officers who are the most likely to advance in their careers and thus (4) maintain operational effectiveness.

HYPOTHESES

Only those submarine officers with high to very high levels of job performance advance from SOBC to SOAC. In fact, for every four SOBC students, approximately only one (or 25%) will ultimately attend SOAC. As fluctuations in motivation tend to impact job performance (Barrick, Stewart, & Piotrowski, 2002; Helmreich, Sawin, & Carsrud, 1986; Kirk & Brown, 2003; Mitchell, 1997), we hypothesized that the motivational scales within the SUBSCREEN test would be the best predictors of ascendancy from SOBC to SOAC. However, we also examined other SUBSCREEN scales, especially those that were included in the SMART (see above) for predicting attrition among enlisted submariners, to determine if they could also explain ascendancy from SOBC to SOAC among officers.

METHOD

Participants

SOBC students who took the SUBSCREEN test per MANMED requirement (Article 15-69, paragraph 2(i)) between October of 1993 and September of 1999 served as the participants in the current study. Data on selection into SOAC for these SOBC students was obtained from the Nuclear Officer Program Manager (N133C). The time between SUBSCREEN test administration at SOBC and selection into SOAC is approximately seven years. Consequently, at the time of this study (March of 2005), selection into SOAC or rejection from SOAC could not be known for many of those tested between October of 1998 and September of 1999 because these students

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[2] Appendix C provides a short discussion on the use of psychological tests for employment decisions.

had not been in the Navy a sufficient amount of time for their SOAC selection decisions to have been made. Thus, these participants were included in the database only if they had been selected into SOAC, but were eliminated from the database otherwise because it could not be assumed that they had, as of yet, failed make SOAC selection.[3]

Predictor Measure

The SUBSCREEN test was used to measure all of the predictors examined in this study. SUBSCREEN consists of many scales that measure Affective (e.g., depression, nervousness), Socialization (e.g., aggression, coercive tendencies), and Motivational (e.g., mistake joining submarines, uncertain about submarines) factors. SUBSCREEN also contains scales that detect response distortion (e.g., faking good), and the scoring program uses additional algorithms to identify response patterns indicative of faking attempts. Additional scales are composed of items used to assess suicidal ideation, claustrophobia, self-criticism, unusual thoughts, and unusual physical complaints. Five to 14 items are used to measure each disposition depending upon the scale. Students respond to each item by using a five-point Likert scale with the following response options: agree strongly, agree, does not apply, disagree, and disagree strongly.

Criterion Measure

Selection and ascendancy into SOAC was coded as 1, and not being selected for SOAC was coded as 0. This dichotomous SOAC ascendancy outcome variable served as the criterion.

Procedure

For this study we utilized a known-group retrospective approach to develop an empirical predictor of advancing to SOAC from SUBSCREEN test scores obtained on SOBC students. Specifically, a known-group, retrospective approach was utilized to determine if scales within the SUBSCREEN test could predict which SOBC students were the most likely to advance in their careers to SOAC, and thus progress to Department Heads within the Submarine Fleet. Thus, a known-group of submarine officers who were selected for SOAC was compared to a known-group of submarine officers who did not reach SOAC, either because they were *not* selected for SOAC, voluntarily withdrew from SUBFOR prior to the SOAC selection process, or disqualified and separated from SUBFOR prior to SOAC. These two known-groups, those who advanced to SOAC and those who did not advance, were compared in terms of their SUBSCREEN test scores, and all of these submarine officers had taken the SUBSCREEN test when attending SOBC. Thus, two databases of submarine officers, those who ascended to SOAC and those who did not, were merged, and correlation and regression analyses were conducted. SUBSCREEN scales that were statistically significant in terms of predicting ascendancy to SOAC in hypothesized directions, either when included as part of a multiple logistic regression equation or in terms of the zero-order correlation with the dichotomous outcome (i.e., ascended to SOAC, 1, versus did not ascend, 0), were selected for inclusion into a new composite scale that has been termed the Submarine Officer Retention Test, or SORT.

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[3] Eliminating all students tested between October of 1998 and September of 1999 did not change the study's findings.

RESULTS

In order to maintain the security of the SUBSCREEN test, the six motivational scales that were found to predict SOAC ascendancy will be referred to as LM1 through LM5 and PM1. LM1 through LM5 are scales that assess a lack of motivation, and high scores on these scales are indicative of motivational problems. PM1 is a scale that assesses a positive motivational characteristic for submarine service, and high scores on this scale are indicative of high levels of job-relevant motivation. Likewise, the response-set scale also found to predict SOAC ascendancy will be referred to as RS1. High scores on the RS1 measure are indicative of the presence of dysfunctional attitudes, dysfunctional traits, and/or attempts at response distortion. The actual names of these SUBSCREEN scales and their respective items can be viewed in Appendix D, which is for official use only, and can be requested from the Commanding Officer, Naval Submarine Medical Research Laboratory, Groton, CT.

When all seven predictors (LM1, LM2, LM3, LM4, LM5, PM1, & RS1) were included in a logistic regression equation with advancement to SOAC as the criterion, we found $R = .25$, $p < .001$. Thus, approximately 6.25% of the variance in advancement to SOAC was explained by this optimal linear composite found within the SUBSCREEN test. Several advantageous initial cutpoints were identified for this prediction equation, which was termed the Submarine Officer Retention Test, or SORT. More detailed results regarding the creation of the SORT, the results for the individual scales of which SORT is composed, and the findings from the cutpoint analyses are described below.

We first correlated the dichotomous outcome, SOAC ascendancy, with each SUBSCREEN scale including SUBSCREEN's SMART. Of these 27 zero-order correlations, six were statistically significant. All six of these correlations were obtained by SUBSCREEN's motivational scales, and thus our hypothesis that the motivational scales would be the best predictors of ascendancy from SOBC to SOAC was confirmed. These correlations are presented in Table 1 along with the internal consistency reliability estimates for each scale.[4]

Table 1

Correlations Between Motivational Scales and SOAC Ascendancy

Scale	SOAC Ascendancy	Coefficient Alpha
LM1	-.054*	.66
LM2	-.085**	.66
LM3	-.102**	.81
LM4	-.133**	.71
LM5	-.091**	.68
PM1	.149**	.74

Note. n ranges from 1,473 to 1,524 because of missing data.

* $p < .05$.   ** $p < .01$.

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[4] Coefficient alpha was used to estimate internal consistency reliability for each scale. Coefficient alpha provides an estimate of the percentage of variance in scale scores that is a function of true variance in the attribute being assessed rather than measurement error. One minus coefficient alpha provides an estimate of the percentage of variance in scale scores due to measurement error. Internal consistency reliability estimates of .70 and higher are generally regarded as acceptable levels for psychological tests (Nunnally, 1978). Coefficient alpha for RS1 was .86.

Consequently, all of these scales were selected for inclusion into a multiple logistic regression equation used to predict SOAC ascendancy. We also utilized the ordinary least squares (OLS) multiple regression technique for comparison purposes, but because of the nature of the dichotomous outcome assumed that the logistic technique would yield more accurate results as OLS can result in impossible predicted outcome values (i.e., below 0 and above 1). Although, RS1 (coefficient alpha of .86) did not obtain a significant zero-order correlation with SOAC ascendancy ($r = -.020$, $p > .10$), we included it in the regression analyses because it is a predictor of attrition among enlisted submariners and thus an integral component of the SMART. Also, by including RS1 in the regression analyses we were able to determine if RS1 could predict variance in SOAC ascendancy above and beyond that predicted by the motivational scales, and once variance in motivation had been partialled from the response-set assessed by RS1. Table 2 presents the results from the OLS and logistic regression equations.

Table 2
Unstandardized Regression Coefficients for All Six Scales in Predicting SOAC Ascendancy

	SOAC Ascendancy	
Scale	OLS Regression	Logistic Regression
LM1	-.040	-.267
LM2	-.042	-.303
LM3	-.024	-.396
LM4	-.064^	-.403^
LM5	-.123**	-.851**
PM1	.140**	.901**
RS1	-.005**	-.039**

Note. n was 1,437 for these analyses due to listwise elimination of cases with missing values. The scale of measurement for RS1 is much greater than that for the other scales, hence the statistical significance for the unstandardized regression coefficient of -.005 for RS1.
^ $p < .10$.   * $p < .05$.   ** $p < .01$.

As can be seen from these analyses, all of the predictors continued to be associated with SOAC ascendancy in predicted directions (e.g., LM1 through LM5 remained negatively associated with SOAC ascendancy), even though not all of them remained statistically significant. Additionally, RS1 clearly predicted a statistically significant portion of variance in SOAC ascendancy in the theoretically defensible direction in the presence of the motivational scales. Using hierarchical OLS regression, we found that RS1 predicted an additional 2.3% of the variance in SOAC ascendancy above and beyond that predicted by the motivational scales ($\Delta R^2 = .023$, $p < .01$).

Using the prediction equations obtained from the OLS and logistic analyses, we calculated predicted values of SOAC ascendancy for each participant, and correlated these values with the actual SOAC ascendancy dichotomous outcome. These results are presented in Table 3.

Table 3
Correlations Between OLS and Logistic Predictions and SOAC Ascendancy

Variable	1	2	3
Logistic Predicted Values [a]	-----		
OLS Predicted Values	.955**	-----	
SOAC Ascendancy	.250**	.229**	-----

Note. n was 1,437 for these analyses due to listwise elimination of cases with missing values.
[a] Predicted values from the logistic regression equation were ultimately termed Submarine Officer Retention Test scores, or SORT scores.
** $p < .01$.

As can be seen from these analyses, the OLS and logistic prediction equations yielded a nearly identical rank order of predicted outcomes, with $r = .955$ ($p < .01$) between these predicted values. However, the predicted values from the logistic regression equation correlated slightly higher with the actual SOAC ascendancy outcome in comparison to the OLS equation, with $R = .250$ ($p < .001$) for logistic regression and $R = .229$ ($p < .001$) for OLS regression, respectively. Consequently, the logistic regression equation was chosen as the preferred prediction equation.

Probability of Ascending to SOAC (SORT) $=$ exp((-.267*LM1)+(-.303*LM2)+(-.396*LM3)+(-.403*LM4)+ (-.851*LM5)+(.901*PM1)+(-.039*RS1)+1.210) / (1+exp((-.267*LM1)+(-.303*LM2)+(-.396*LM3)+(-.403*LM4)+ (-.851*LM5)+(.901*PM1)+(-.039*RS1)+1.210)).

Examination of this logistic regression equation reveals the following: (1) As scale scores for LM1 through LM5 increase, the probability of ascending to SOAC decreases, (2) As scale scores for PM1 increase, the probability of ascending to SOAC increases, and (3) As scale scores for RS1 increase, the probability of ascending to SOAC decreases. As each regression coefficient for these scales remained in the predicted direction (see Table 1), each of these scales was retained for the final regression equation even though, as stated above, not all of the respective regression coefficients were statistically significant (see Table 2).

Were these scales to belong to different tests that are time-consuming and costly to administer, it would be advisable to select only those scales that retained statistically significant regression coefficients for the ultimate creation of the actionable metric, or prediction equation. However, in this case each scale is contained within the 240-item SUBSCREEN test, so reducing the number of scale predictors to save time and money is not a factor. Also, it is often noted that redundancy in psychological measurement is advantageous for obtaining more reliable, and ultimately more valid, assessments of individual differences. Indeed, the psychometric reliability of a test is partly a function of necessary redundancy in the test's item content (Nunnally & Bernstein, 1994). Thus, redundancy of scales for predicting important outcomes, such as SOAC ascendancy, is also advantageous because it ultimately results in a more reliable and valid prediction equation. Also, when feasible, several measures (e.g., scales, tests, etc.) should be utilized when generating a product that may be used to enhance important human resource decisions (e.g., selection for training opportunities) as these decisions should not be based on just one factor. Thus, we chose to maintain the redundancy of these scales as predictors in the final regression equation because (1) their redundancy should increase the validity of the ultimate

prediction as noted, (2) their zero-order correlations with SOAC ascendancy were statistically significant, (3) these correlations were in the predicted directions, and (4) the corresponding regression coefficients remained in the predicted directions when all scales were entered into the prediction equation.

In sum, using the logistic regression technique we found that these six SUBSCREEN scales could be used to form an optimal linear composite that predicted advancement to SOAC. We termed this prediction equation the Submarine Officer Retention Test, or SORT. Table 4 presents the mean and standard deviation for the predicted values from the SORT along with the mean and standard deviation for the dichotomous outcome variable of SOAC ascendancy.

Table 4

*Minimums, Maximums, Means and Standard Deviations for SORT and SOAC Ascendancy*

	SORT				SOAC Ascendancy		
Min	*Max*	*M*	*SD*	*Min*	*Max*	*M*	*SD*
.000	.630	.223	.100	.000	1.000	.226	.419

Note. n was 1,437 for SORT and 1534 for SOAC ascendancy.

Clearly, the mean value obtained from the SORT equation ($M = .223$) is very close to the base rate of advancement to SOAC in the current sample, which is approximately 23% and given by the mean of the dichotomous SOAC ascendancy outcome variable. Figure 1 displays a histogram of SORT scores for the two known-groups, those who were not selected for SOAC versus those who attended SOAC.

Figure 1

Histogram of SORT Scores Displayed by SOAC Ascendancy Groups
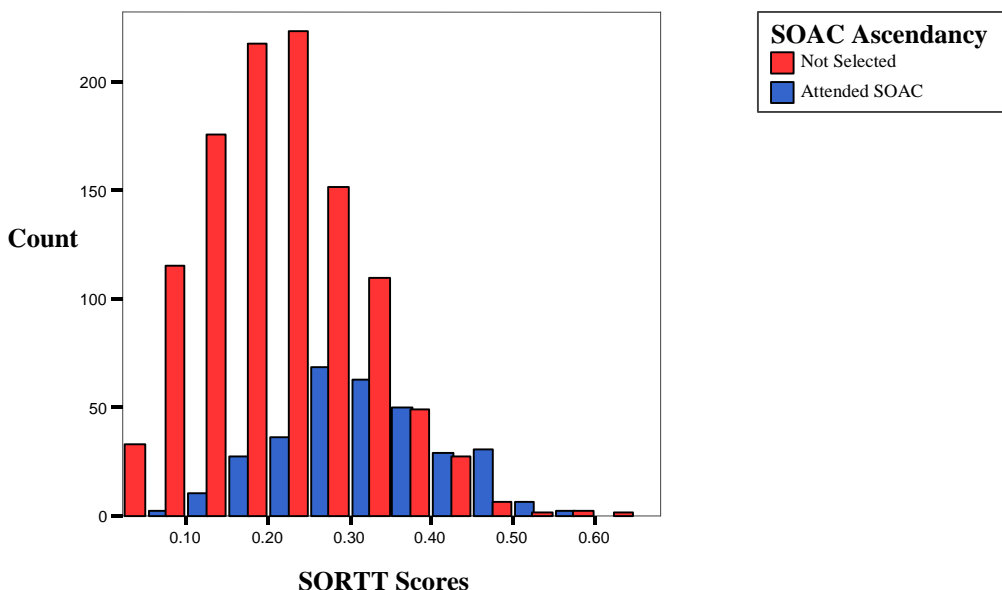
As can be seen from Figure 1, the SORT is capable of discriminating between the two groups, and various cutpoints can be selected to investigate the discriminatory power of this prediction equation. Thus, several cutpoints were identified for the SORT, and the results from these cutpoint analyses are presented in Table 5.

Table 5
SORT Category by SOAC Ascendancy Crosstabulation

			SOAC Ascendancy		Total
			No (0)	Yes (1)	
SORT Category	Low	Count	195	18	213
		% within SORT Category	91.5%	8.5%	100.0%
		% within SOAC Ascendancy	17.5%	5.6%	14.8%
		% of Total	13.6%	1.3%	14.8%
-1.08 *SD*	Below Avg.	Count	347	57	404
		% within SORT Category	85.9%	14.1%	100.0%
		% within SOAC Ascendancy	31.1%	17.6%	28.1%
		% of Total	24.1%	4.0%	28.1%
-.23 *SD*	Avg.	Count	431	155	586
		% within SORT Category	73.5%	26.5%	100.0%
		% within SOAC Ascendancy	38.7%	48.0%	40.8%
		% of Total	30.0%	10.8%	40.8%
+1.02 *SD*	Above Avg.	Count	105	57	162
		% within SORT Category	64.8%	35.2%	100.0%
		% within SOAC Ascendancy	9.4%	17.6%	11.3%
		% of Total	7.3%	4.0%	11.3%
+1.78 *SD*	High	Count	36	36	72
		% within SORT Category	50.0%	50.0%	100.0%
		% within SOAC Ascendancy	3.2%	11.1%	5.0%
		% of Total	2.5%	2.5%	5.0%
Total		Count	1114	323	1437
		% within SORT Category	77.5%	22.5%	100.0%
		% within SOAC Ascendancy	100.0%	100.0%	100.0%
		% of Total	77.5%	22.5%	100.0%

As can be seen from Table 5, the SORT categories were labeled as low, below average, average, above average, and high. These SORT category labels correspond to the probability of advancing to SOAC when taking the base rate of ascendancy into account, which is highlighted in green and approximately 23% according to these results. For example, SOBC students who fell into the high category on the SORT (a total of 72 out of 1437 students) had a 50% probability of advancing to SOAC (highlighted in yellow) in comparison to the base rate ascendancy of 23%. Note that for SOBC students to be placed into the high category they had to obtain SORT scores that were at least +1.78 standard deviations (*SD*) above the mean, or higher. The other standard deviations to which cutpoints for the categories on the SORT correspond can be seen in the far-left column of the table above the +1.78 *SD* value, which is adjacent to the high SORT category.

Thus, for example, those in the low SORT category were –1.08 *SD* beneath the mean or lower on the SORT.

In sum, we were able to identify various cutpoints on the SORT that could be used to enhance retention or selection decisions for submarine training. Notice that were SUBFOR to use the SORT by eliminating from the submarine training pipeline all those who fall into the low SORT category (i.e., the bottom 14.8%) because they are not likely to ascend to SOAC, then SUBFOR would be incorrect only 18 out of 213 times, or 8.5% of the time. Likewise, were SUBFOR to use SORT by eliminating all those who fall into the below average category or lower (i.e., the bottom 42.9%) because they are not likely to ascend to SOAC, then SUBFOR would be incorrect only 75 out of 617 times, or 12.2% of the time.

DISCUSSION

The current study clearly indicates that SUBSCREEN test scores can predict ascendancy from SOBC to SOAC. The motivational scales of which SUBSCREEN's SORT is composed were hypothesized to be the best predictors of ascendancy, and this hypothesis was confirmed. As increases in motivation are known to lead to increases in job performance (Barrick, Stewart, & Piotrowski, 2002; Helmreich, Sawin, & Carsrud, 1986; Kirk & Brown, 2003; Mitchell, 1997), and only high performing officers are selected to attend SOAC, perhaps this result is not surprising.

However, the fact that SUBSCREEN's SORT predicts ascendancy from SOBC to SOAC with $R = .250$ ($p < .001$) could also be viewed as both potentially useful and perhaps profound for the following reasons. First, there is extensive range restriction among the current study participants, and range restriction decreases the predictive power of screening instruments, psychological tests, and measures of individual differences in general (Cohen & Cohen, 1983; Hunter & Schmidt, 1990; Nunnally & Bernstein, 1994; Pearson, 1903; Powers, 2004). To understand the extent of the range restriction in the sample investigated, it should be noted that administration of the SUBSCREEN test occurred at SOBC for these study participants. In order to enter SOBC, a submarine officer must have graduated from college with very respectable grades, and many attend the Naval Academy, which is a very selective institute. Furthermore, these college graduates must all pass security clearance procedures. Additionally, they must complete accession, Nuclear Power School, and Nuclear Prototype School in order to enter SOBC. This training is generally equivalent to obtaining a Masters in Nuclear Engineering, and is exceedingly rigorous. Thus, as those with less motivation and ability attrite along this career path at various points (e.g., during college, during Nuclear Power School, etc.), it is reasonable to assert that any sample of SOBC students is greatly restricted in range with respect to many characteristics as these students belong to a highly motivated and highly intelligent population. In sum, the current findings indicate that SUBSCREEN's SORT was capable of capturing individual differences in motivational traits among SOBC students that predicted later advancement to SOAC, and we can conclude that this result occurred *in spite of* any range restriction in the sample.[5]

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[5] Appendix E provides a mathematical estimation of the amount of range restriction in the SOBC sample and a subsequent re-estimation of the relationship between the SORT and SOAC ascendancy after correcting for range restriction in the predictor (i.e., the SORT).

Second, the time span between administration of the SUBSCREEN test at SOBC and later advancement to SOAC is approximately seven years. Consequently, advancement to SOAC is a very temporally distal outcome in light of the acquisition of the motivational attributes with the SUBSCREEN test at SOBC, and yet SUBSCREEN's SORT still predicted SOAC ascendancy. The fact that among enlisted personnel SUBSCREEN's SMART predicts indicators of training attrition acquired months after test administration (e.g., correlations of .35 and .50, $p < .001$) somewhat better than fleet attrition acquired several years later (e.g., .25, $p < .001$; Bing & Eisenberg, 2004) does suggest that perhaps changes in persons over time and intervening situational events can attenuate the predictive power of the test, but over the span of many years. Thus, once again, *in spite of* the large time span (i.e., approximately seven years) between test administration and the outcome (i.e., SOAC ascendancy) studied here, the SORT was still capable of capturing stable motivational attributes that were manifested in terms of fleet attrition for some, and high job performance and advancement to SOAC for others.

Third, the base rate of the outcome, SOAC ascendancy, was approximately 23% in the sample studied here. This low base rate also attenuates the relation (i.e., correlation or R) observed between SUBSCREEN's SORT and SOAC ascendancy. This attenuation in observed relations will always occur when the predictor is a continuous score, like the SORT, the outcome is dichotomous, and the base rate of occurrence in the dichotomous outcome deviates from a 50/50 (present/absent) split (Cohen & Cohen, 1983; Nunnally & Bernstein, 1994). In the current data, with a 23/77 split (i.e., a 23% base rate) on the SOAC ascendancy outcome, the maximum possible correlation or R between the SORT and SOAC ascendancy was approximately .730 rather than 1.00. As a consequence, once again, the observed R of .250 ($p < .001$) between the SORT and the SOAC ascendancy outcome was observed *in spite of* this deviation from a 50/50 split in the dichotomous SOAC outcome. Were we to also assume that the dichotomous SOAC ascendancy outcome was a manifestation of a continuous and normally distributed construct (e.g., job performance, leadership ability), then the observed R could be re-estimated. In fact, when assuming the dichotomous SOAC outcome is a function of a continuous, normally distributed construct, re-estimating the current R of .250, which is essentially a point biserial correlation between SORT and the dichotomous SOAC outcome, results in a biserial correlation of .347 (Cohen & Cohen, 1983).

Last, we could also interpret the .250 relation observed here for the SORT in the context of well-conducted meta-analyses investigating the relationship between personality measures of Conscientiousness and job performance. Among personality traits, the Big Five personality factor of Conscientiousness has been recognized as the strongest and most generalizable predictor of job performance (Barrick & Mount, 1991; Hurtz & Donovan, 2000; Tett, Jackson, & Rothstein, 1991).[6] However, various meta-analyses have demonstrated that the uncorrected mean validity coefficients between self-reports of Conscientiousness and measures of job performance range from .12 to .18 (Barrick & Mount, 1991; Hough, Eaton, Dunnette, Kamp, & McCloy, 1990; Hurtz & Donovan, 2000; Mount & Barrick, 1995; Tett et al., 1991). Thus, in the context of

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[6] The Big Five taxonomy characterizes personality as being composed of five major second order factors: Conscientiousness, Extraversion, Openness, Agreeableness, and Emotional Stability. Of these factors, Conscientiousness is generally recognized as the most work-relevant for the majority of occupations.

these meta-analytic findings, the .250 observed here for the SORT in predicting SOAC ascendancy is a respectable value.

In sum, we may reasonably assume that the relationship found here between SUBSCREEN's SORT and advancement to SOAC is a lower bound estimate of the true relationship, and were the SORT to be implemented for submarine training selection decisions then the Navy may accrue several financial benefits. These financial benefits are subsequently discussed among other conclusions and recommendations.

CONCLUSIONS AND RECOMMENDATIONS

The current findings indicate that SUBSCREEN's SORT captures stable individual differences in motivation that influence a submariner's ability to ultimately ascend to higher leadership positions within SUBFOR. The cutpoint analyses pursued here also indicated that the SORT may provide an actionable metric that can improve submarine training selection decisions, especially if used to eliminate the low and below average SORT categories, which had only a 12.2% chance of ascending to SOAC. This would be a large force reduction, eliminating approximately 43% of the candidate pool, but this portion of the candidate pool has a 12.2% chance of ascending to SOAC in comparison to the base rate of 23% (i.e., about half the chance of the randomly selected candidate). This type of use of the SORT would ultimately help the Navy to meet HCS objectives, which include attempts to use actionable metrics to decrease overall manpower costs while maintaining operational effectiveness. Additionally, the use of the SORT to eliminate officers from the submarine training pipeline need not lead to a lack of career advancement for all of these officers as they (1) would be removed from a career path in SUBFOR where they are not predicted to be successful and (2) could be placed into more suitable career paths where retention and advancement are more likely.

In order to avoid spending training dollars, in particular the large sums of money needed for nuclear power training, on officers in SUBFOR who are not likely to ascend to SOAC, the Navy could consider moving the administration of the SUBSCREEN test to earlier stages in the submarine training pipeline. As force reduction initiatives increase, administration of the SUBSCREEN test prior to Nuclear Power School and the use of the SORT for selection decisions could save the Navy a substantial amount of money by reducing the overall number of submarine officer trainees while simultaneously retaining the trainees that are the most likely to advance in their submarine careers.

There are two caveats to this recommendation. First, as SUBSCREEN is currently administered during SOBC, and SOBC students have completed an extensive amount of nuclear power training by the time they take the test, the attitude toward item responses by the average SOBC student may be very different than the attitude of a pre-Nuclear Power School submarine officer candidate. This possible change in test-taker attitude and motivation could attenuate the validity of the test, and thus the predictive power of SUBSCREEN's SORT (Bing, Whanger, Davison, & VanHook, 2004). However, several scales of which the SORT is composed are context-specific, and contextualized to the submarine service. Research in personality assessment has shown that scales with a high degree of context-specificity may maintain their validity even in the presence of situational factors that cause respondents to engage in response distortion via socially

desirable responding or faking good attempts (Bing et al., 2004; Schmit, Ryan, Stierwalt, & Powell, 1995). Also, SORT's RS1 scale is sensitive to response distortion, and RS1 scale scores increase as response distortion increases. Thus, because RS1 is a component of the SORT, and negatively weighted in the SORT equation, SORT scores will be resilient to faking attempts. Specifically, if faking attempts increase among respondents, then SORT scores will subsequently decrease for these respondents, leading to the prediction that they are not likely to ascend in SUBFOR according to their SORT scores.

Second, if the administration of the SUBSCREEN test were to be moved to an earlier point in the training pipeline, then the mental health examination referral process used to meet the MANMED requirement for submarine duty articulated in Article 15-69, paragraph 2(i) of that document (see Appendix B) may need to be transferred to that same point as well, and thus to the same location as the administration site of the SUBSCREEN test. However, because the MANMED also mandates psychological screening for nuclear field duty in Article 15-70, paragraph 2(c) of that document, perhaps the psychological screenings for both duties could occur at the same point in the training pipeline, which would eliminate some redundancy of operation and possibly lead to fiscal savings for the Navy.[7]

In sum, moving the administration of the SUBSCREEN test upstream in the training pipeline could result in substantial financial savings for the Navy, and the SORT's validity should not be overly attenuated as a consequence. Also, as less range restriction would be present among pre-Nuclear Power School submarine officer candidates, the SORT's validity may ultimately remain stable under this potential administrative change in testing conditions. Additional investigations into the validity of the SUBSCREEN test and the SORT should be undertaken if and when the administration of the SUBSCREEN test is moved to an earlier stage in the submarine training pipeline to meet HCS objectives.

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[7] MANMED Article 15-70, Nuclear Field Duty (Nuclear Power / Nuclear Weapons), paragraph 2(c) begins as follows: "*Psychiatric*. Because of the potential for misuse of devices and sources emitting ionizing radiation, the psychological fitness of applicants must be carefully appraised by the examining physician. The objective is to elicit evidence of tendencies which militate against assignment to these critical duties." It should be noted that seven of the eight tendencies listed in this Article which prevent assignment to nuclear field duty are also mentioned in Article 15-69, paragraph 2(i), and also prevent assignment to submarine duty. Thus, the redundancy in the traits or tendencies that prevent assignment to these duties could potentially be assessed at one point in the training pipeline.

ACKNOWLEDGEMENTS

BIOGRAPHICAL SKETCHES

Mark Bing, Ph.D. is the director of the psychological screening program for the U.S. Navy's Submarine Force, and in this capacity he serves as the principal investigator of the SUBSCREEN program at NSMRL. Dr. Bing obtained his M.S. in Experimental Psychology from Villanova University, and his Ph.D. in Psychology from the University of Tennessee at Knoxville. Before coming to NSMRL, he served as an assistant professor for two years in the graduate program in I/O Psychology at the University of Tennessee at Chattanooga. Dr. Bing has published articles on job performance, personality measurement, test development, and test validation in journals such as the *Journal of Applied Psychology, Journal of Organizational Behavior, Journal of Personality Assessment,* and the *Journal of Business and Psychology*. Dr. Bing recently developed the SubMarine Attrition Risk Test (SMART), which is a subset of the SUBSCREEN test that predicts adverse attrition among enlisted submariners.

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APPENDIX A. Naval Submarine School (NAVSUBSCOL) Instruction 6420.1, Excerpt

Subj: NAVAL SUBMARINE SCHOOL SUBSCREEN ADMINISTRATION

Ref: (a)   Manual of the Medical Department (MANMED P117)

Encl: (1)   Basic Enlisted Submarine School (BESS) SUBSCREEN
                Administration Procedures

1.   <u>Purpose</u>. To establish formal procedures for administering SUBSCREEN to submarine force officer and enlisted accessions and for documenting the SUBSCREEN process at Naval Submarine School.

2.   <u>Discussion</u>. Reference (a) states that the psychological fitness of applicants for submarine training must be carefully appraised. SUBSCREEN was developed for this purpose and is administered to all submarine officer and enlisted basic course students at Naval Submarine School.

3.   <u>Action</u>

        a. Director, General Skills Training (N62) shall institute the procedure delineated in enclosure (1) for BESS students.

        b. Director, Submarine Officer Basic Course (SOBC) (N22) shall institute the procedures delineated in enclosure (2) for SOBC students.

        c. Directors of SOBC (N22) and General Skills Training (N62) are jointly responsible for updating this instruction when necessary.

                                W. A. Peters (signed)

Distribution:
CO/XO
Admin
N2
N6
Mental Health
NSMRL (3)
LT Davis (Sick Call)

4.   <u>Scoring and Evaluation</u>
        a. The NSMRL Examiner scores SUBSCREEN. The evaluation criteria are then applied to SUBSCREEN scale scores. The NSMRL Examiner records on the class roster whether or not a student's score warrants referral to the Mental Health Clinic (MHC).

APPENDIX B. Manual of the Medical Department (MANMED) Article 15-69 para 2(i)

"*Psychiatric.* Because of the nature of the duties and responsibilities of each person in a submarine, the psychological fitness of applicants for submarine training must be carefully appraised. The objective is to elicit evidence of tendencies which might prevent satisfactory adjustment to submarine life. Among these are below average intelligence, claustrophobic tendencies, lack of motivation, unhealthy motivation, history of personal ineffectiveness, difficulties in interpersonal relations, lack of adaptability, or personality disorders.

(1) Any examinee diagnosed by a psychiatrist, clinical psychologist, or UMO as suffering from depression, psychosis, manic-depression, paranoia, severe neurosis, severe borderline personality, or schizophrenia will be recommended for submarine disqualification at the time of initial diagnosis. Waiver request may be submitted per section V.

(2) Those personnel with diagnosed suicidal ideation will have their cases reviewed, as a minimum, by the type commander (TYCOM) medical officer, if a UMO, for fleet personnel, or MED-21 if at a shore establishment, to determine the necessity for disqualification or return to duty. Personnel with suicidal gestures or attempts will be recommended for submarine disqualification. Waivers will be considered on individual basis per section V.

(3) Those personnel with minor psychiatric disorders such as acute situational stress reactions will be evaluated by the local group or squadron UMO in conjunction with a formal psychiatric evaluation when necessary. Those cases which resolve completely, quickly, and without significant psychotherapy can be found fit for submarine duty by the responsible local UMO, if deemed appropriate. Those cases in which confusion exists must be reviewed by the TYCOM medical officer, if a UMO, for fleet personnel, or MED-21 for shore-based personnel. It must be stressed that any consideration for return to duty in these cases must address the issue of whether to service member, in the written opinions of the UMO and the member's commanding officer, can successfully return to the specific stresses and environment of submarine duty."

APPENDIX C. Implications of the Uniform Guidelines on Employee Selection Procedures (1978) for the Use of SUBSCREEN's SMART and the SORT

With respect to the current 6.4, BUMED-funded Test and Evaluation (T&E) of the SMART, it is relevant that the Federal Government, via the Uniform Guidelines on Employee Selection Procedures (1978), does not make a distinction between tests like SUBSCREEN, which are self-report questionnaires of attitudes, personality, motivation, environmental adaptability and psychological functioning, and tests like the Armed Services Vocational Aptitude Battery (ASVAB), which is a cognitive ability test. As such, it is common practice for those with a need to know to receive scores on tests to make informed decisions regarding not only whether or not employees in both the private sector and the government (e.g., military personnel) should be trained, retrained, demoted, or referred, etc., as specified in the Uniform Guidelines with respect to the scope of test use (see below), but also whether or not the test is working to improve these decisions. Thus, for example, many instructors, chiefs, and other leaders at NAVSUBSCOL have access to ASVAB scores of BESS students because they need those scores to make decisions about their training, transfer, rate qualification, etc.

Thus, we have good reason to believe that NAVSUBSCOL will use the SMART results appropriately given their extensive experience not only with testing data, such as class grades, the ASVAB, and the current "referred versus not referred" SUBSCREEN information that they obtain from the SUBSCREEN program, but also because they are very experienced in routinely dealing with sensitive information on their students, such as security clearance information.

It should be noted that the Uniform Guidelines on Employee Selection Procedures (1978) apply to more than just selection decisions. From Section 2 of the Uniform Guidelines under "B. Employment decisions" we have the following quote from the guidelines:

> "These guidelines apply to tests and other selection procedures which are used as a basis for any employment decision. Employment decisions include but are not limited to hiring, **promotion**, **demotion**, membership (for example, in a labor organization), **referral**, **retention**, and licensing and **certification**, to the extent that licensing and certification may be covered by Federal equal employment opportunity law. **Other selection decisions, such as selection for training or transfer, may also be considered employment decisions if they lead to any of the decisions listed above**."[8]

As such, it can be concluded that a legal precedent is available for the release of the SMART to NAVSUBSCOL, and for NAVSUBSCOL's use of the SMART in the psychological screening of future prospective submariners. Furthermore, as the SORT is a subset of the SUBSCREEN test, this legal precedent applies to the use of SORT for employment decisions as well.

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[8] **Bold** font is added for emphasis and does not appear in the original text.

APPENDIX D. Names of SUBSCREEN's SORT Scales and the Respective Items

Appendix D is for Official Use Only, and any request for disclosure of any information contained in this appendix should be forwarded to the Commanding Officer, Naval Submarine Medical Research Laboratory, Groton, CT.

APPENDIX E. Re-estimation of the Relationship Between the SORT and SOAC Ascendancy after Correcting for Predictor Range Restriction

In order to estimate the amount of range restriction on SORT scores for SOBC students ($n = 1,437$), we calculated SORT scores for a large sample of BESS students ($n = 25,277$) from their SUBSCREEN test results. The majority of the BESS student population is composed of high school graduates who enter BESS after completing basic training. However, it should be noted that (1) SORT scores are largely a function of motivational traits (see Table 1), (2) BESS students are highly motivated to enter the Submarine Force, which is why they volunteered for submarine duty, and (3) there are minimum ability requirements to enter BESS, which restricts the range of BESS students on ability attributes as well. Following Cohen and Cohen (1983), we used the standard deviation (*SD*) on the SORT scores from the BESS student sample to re-estimate the relationship between the SORT and SOAC ascendancy among SOBC students. First, note that the *SD* on the SORT for SOBC students was approximately .100 (i.e., .09962), whereas it was approximately .112 (i.e., .11175) for BESS students. Thus, SORT scores in the SOBC student sample were restricted in range by approximately 11% in comparison to the dispersion of SORT scores found in the BESS student sample. Using Cohen and Cohen's (1983, p. 70) formula, we found that when correcting for this estimate of range restriction in SORT scores among SOBC students the relationship between SORT and SOAC ascendancy increased from the observed *R* of .250 to .280.

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1. REPORT DATE (DD-MM-YYYY) 28-03-2005	2. REPORT TYPE Technical Report	3. DATES COVERED (From - To) 01 September 2004 - 28 March 2005

4. TITLE AND SUBTITLE

THE PREDICTION OF SUBMARINE OFFICER ADVANCED COURSE ASCENDANCY FROM SUBSCREEN TEST SCORES

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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Rick Severinghaus, CAPT, USN (Ret.)

5d. PROJECT NUMBER
N0002404WX01546

5e. TASK NUMBER

5f. WORK UNIT NUMBER
50501

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

NAVSUBMEDRSCHLAB
Box 900
Groton, CT 06349-5900

8. PERFORMING ORGANIZATION REPORT NUMBER

NSMRL TECHNICAL REPORT #1238

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)
CNO-N779, NAVSEA, & COMSUBNAVFOR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The DON began a Human Capital Strategy (HCS) agenda in 2004. The HCS agenda attempts to (1) decrease overall manpower costs while improving effectiveness, (2) implement an integrated approach to career advancement, and (3) establish actionable metrics to accomplish these goals. One way SUBFOR could meet the HCS agenda would be to select fewer officers for submarine training, which would reduce manpower costs. However, in order to avoid a subsequent manpower shortage from this force reduction, SUBFOR would need to have an actionable metric that would allow for the selection of those officers for submarine training who are the most likely to advance. This study investigated whether the SUBSCREEN test could be used to provide a predictor of advancement among officers within SUBFOR. Using regression, we found that seven scales within the SUBSCREEN test formed an equation that predicted which SOBC students were likely to advance to SOAC, with $R = .25$ ($p < .01$). Several cutpoints were identified for this prediction equation, which was termed the Submarine Officer Retention Test, or SORT.

15. SUBJECT TERMS

SUBSCREEN, psychological screening, attrition, advancement, job performance, environmental adaptability, personnel selection, test validity, test validation, test development

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	SAR	29	M. Fitzgerald, Publications Manager
U	U	U			19b. TELEPHONE NUMBER (Include area code) (860) 694-2442